

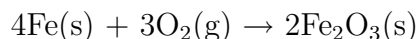
CHEM102 Exam I (Jul 20 2009).

33 $\frac{1}{3}$ points / problem with maximum of 100 points.

1. For $2\text{NaCl}(\text{aq}) + \text{Ag}_2\text{SO}_4(\text{aq}) \rightarrow 2\text{AgCl}(\text{s}) + \text{Na}_2\text{SO}_4(\text{aq})$ the following data was obtained at 298 K:

[NaCl] (mol L ⁻¹)	[Ag ₂ SO ₄] (mol L ⁻¹)	Initial rate of reaction (mol L ⁻¹ s ⁻¹)
0.104	0.084	28.8
0.104	0.021	1.80
0.208	0.021	7.20

- What is the rate law?
 - What is the value of the rate constant $k_{298\text{ K}}$ (where the subscript refers to temperature)?
 - What rate law would you expect if this was an elementary reaction?
 - If the pre-exponential factor A is independent of temperature and $k_{400\text{ K}} = 10 \times k_{298\text{ K}}$, what would be the activation energy E_A (the gas constant $R = 8.31451\text{ J K}^{-1}\text{mol}^{-1}$)?
2. Consider the following elementary reaction: $\text{NO}_2(\text{g}) + \text{NO}_2(\text{g}) \rightarrow \text{N}_2\text{O}_4(\text{g})$. The rate constant $k = 0.044\text{ M}^{-1}\text{s}^{-1}$ is known.
- What is the reaction order with respect to NO_2 ?
 - If the initial concentration of NO_2 is 0.200 M, what is the concentration of NO_2 after 10 minutes?
 - What would then be the concentration of N_2O_4 after 10 minutes?
 - How would you expect entropy to change in this reaction (and why)?
3. The formation of iron oxide follows the reaction at 298 K temperature:



where $\Delta H_{\text{rxn}}^\circ = -824.2\text{ kJ/mol}$ and $\Delta S_{\text{rxn}}^\circ = -549.7\text{ J/(K mol)}$.

- Calculate $\Delta G_{\text{rxn}}^\circ$. Can you predict spontaneity of the reaction using this thermodynamic variable?

- b) Calculate $\Delta S_{\text{universe}}^{\circ}$. Can you predict spontaneity of the reaction using this thermodynamic variable?
- c) Is there heat transfer involved in this reaction between the system and the surroundings? Calculate q_{sys} and q_{surr} .
- d) Can you predict the sign of $\Delta S_{\text{rxn}}^{\circ}$ from the chemical equation (and why)?